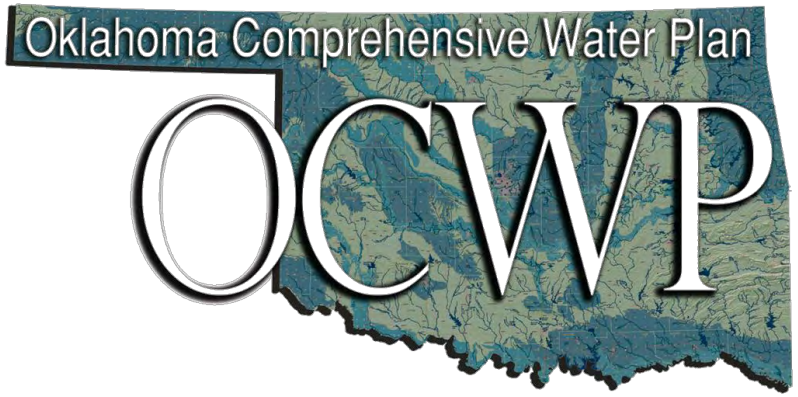


OCWP Technical Studies: 2010 Progress and a Look Ahead to 2011

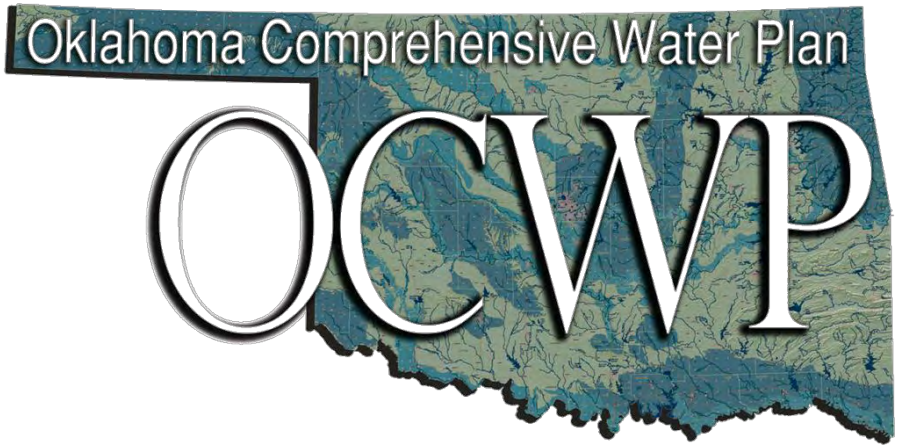
John Rehring – CDM

Governor's Water Conference
Norman, Oklahoma
October 27, 2010

US Army Corps of Engineers

State of Oklahoma OWRB Water Resources Board the water agency

CDM



Presentation Overview

- Technical Studies Overview
- Work Completed to Date
- Watershed Planning Regional Reports
- Additional Work In Progress

Technical Studies in 4 Major Phases

2007 - 2009

2009 - 2010

2011

- Foundational elements
  - *Demands, supply availability, & shortages*
- Analysis
  - *Water allocation modeling*
  - *What-if analyses – supply/demand uncertainties*
  - *Management & administration*
- Supply Planning
  - *Regional needs and potential solutions*
  - *Watershed Planning Region Reports*
  - *Detailed provider-level assessments*
- Documentation

Common Themes

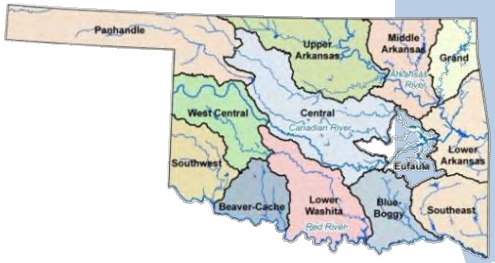
Oklahoma Comprehensive Water Plan

OCWP

US Army Corps of Engineers.

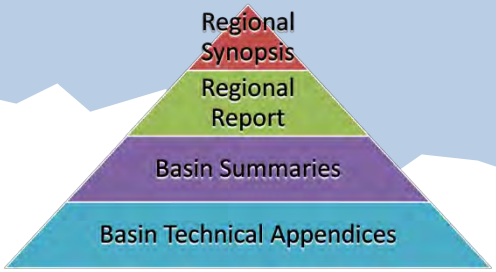
State of Oklahoma OWRB Water Resources Board the water agency

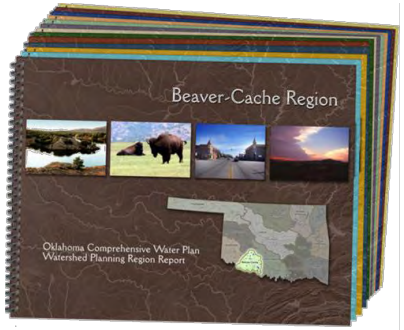
New model for local-state-federal partnerships



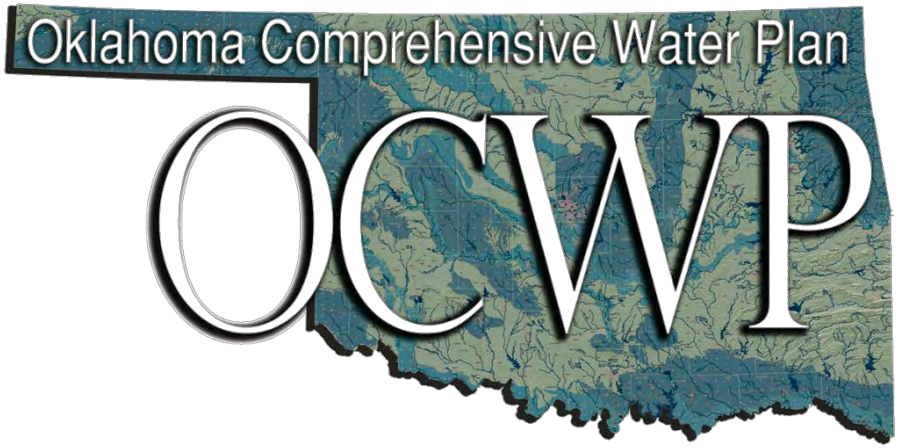
Watershed and regional approach

Technical information in multiple levels of detail





Information to support informed decision-making, policies, and local water planning



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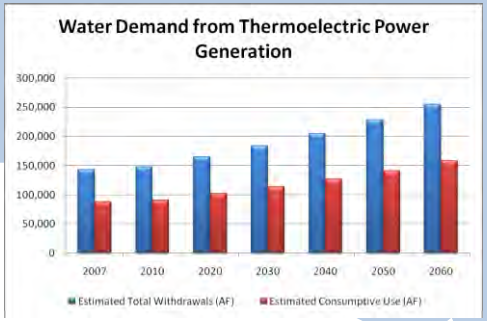
Tools Developed for the OCWP Update

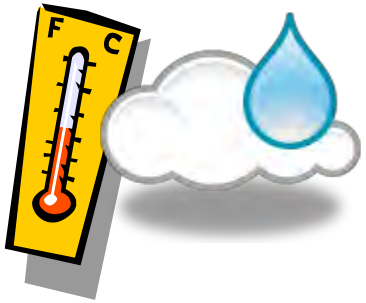
under USACE / OWRB authorities

Supply/Demand Gap Tool

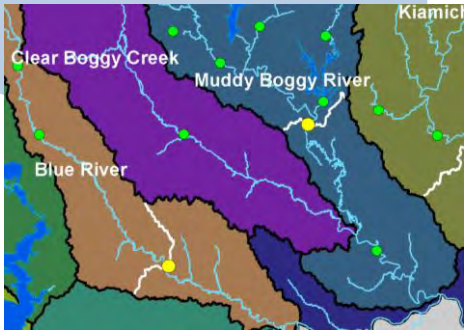
Reservoir Yield Model



Demand Projection Model

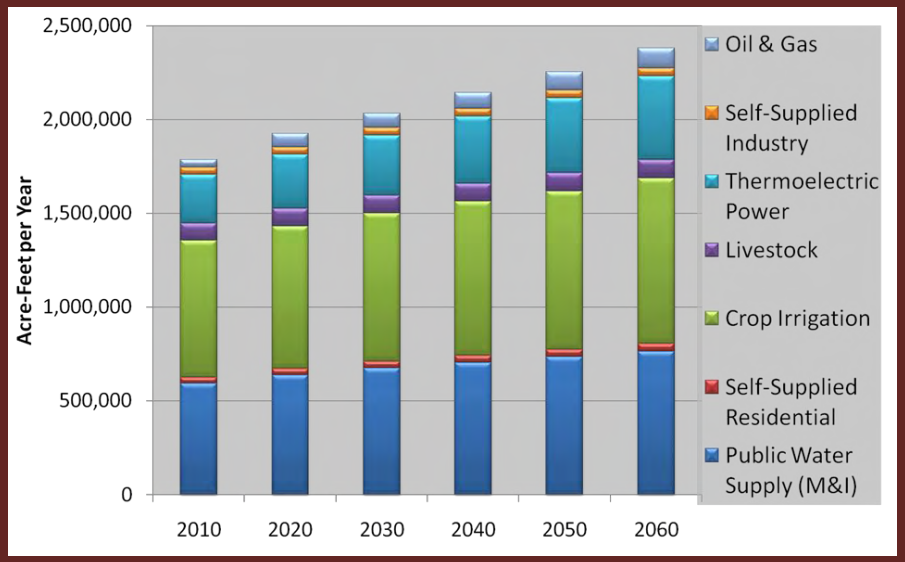


Climate Demand Model

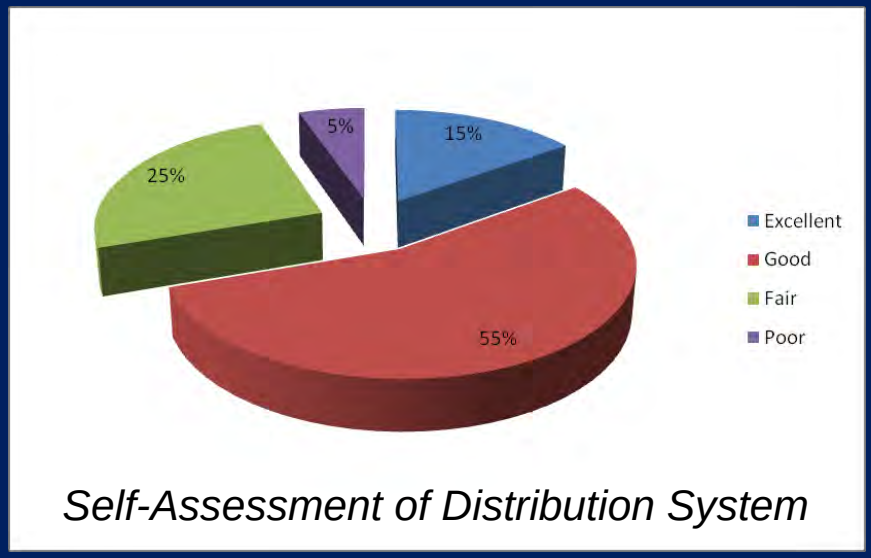


Water Allocation Models

Analyses and Reports Completed



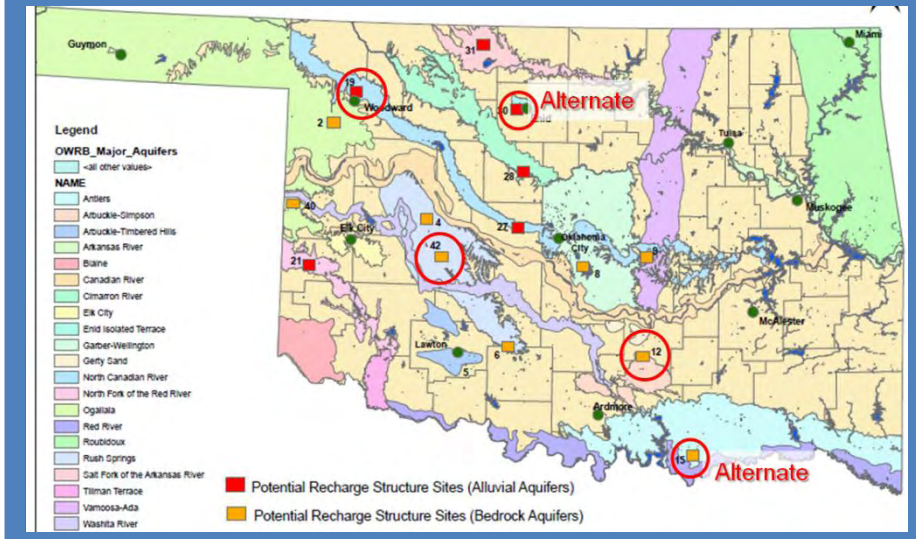
Water Demand Forecast Report
October 2009



Self-Assessment of Distribution System

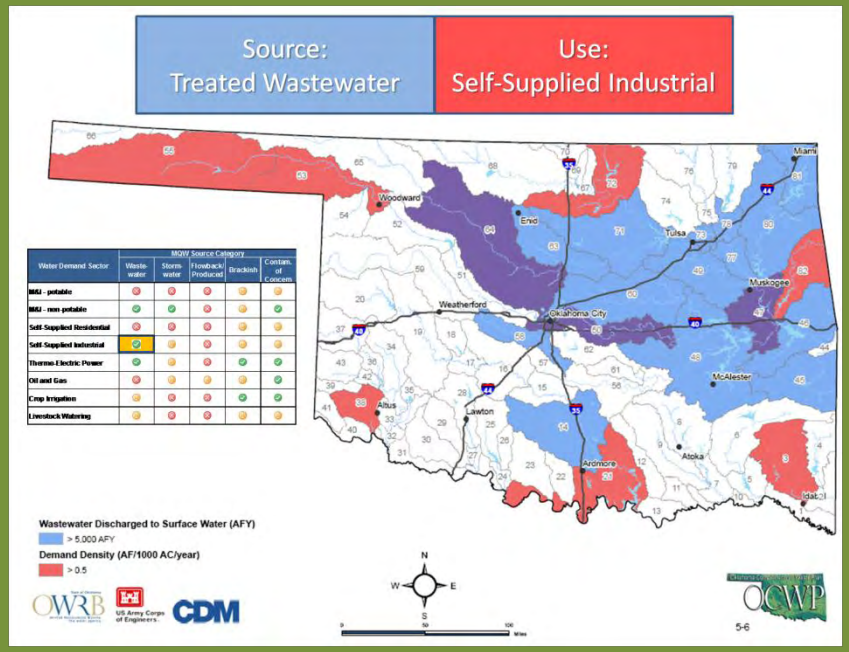
Provider Survey Summary Report
December 2009

Analyses and Reports Completed



Aquifer Recharge Work Group

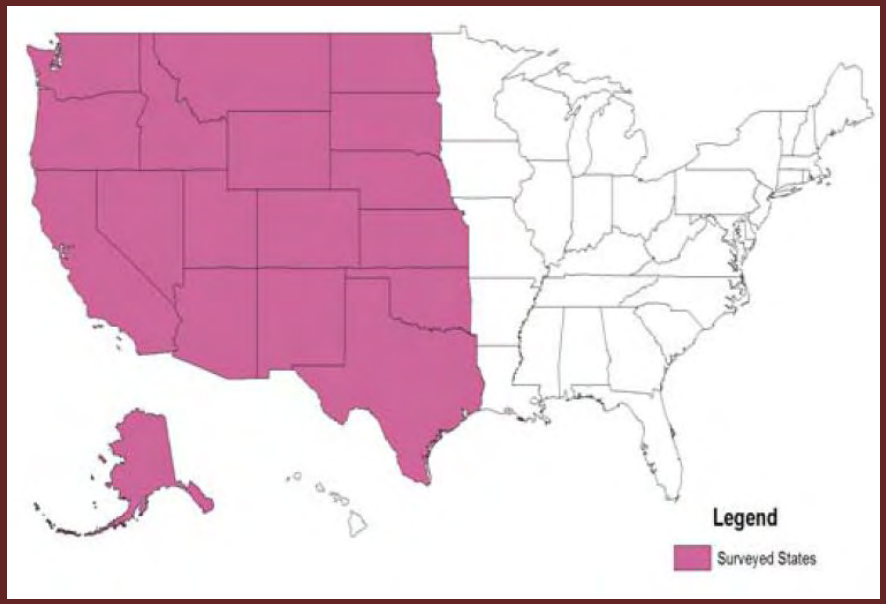
June 2010



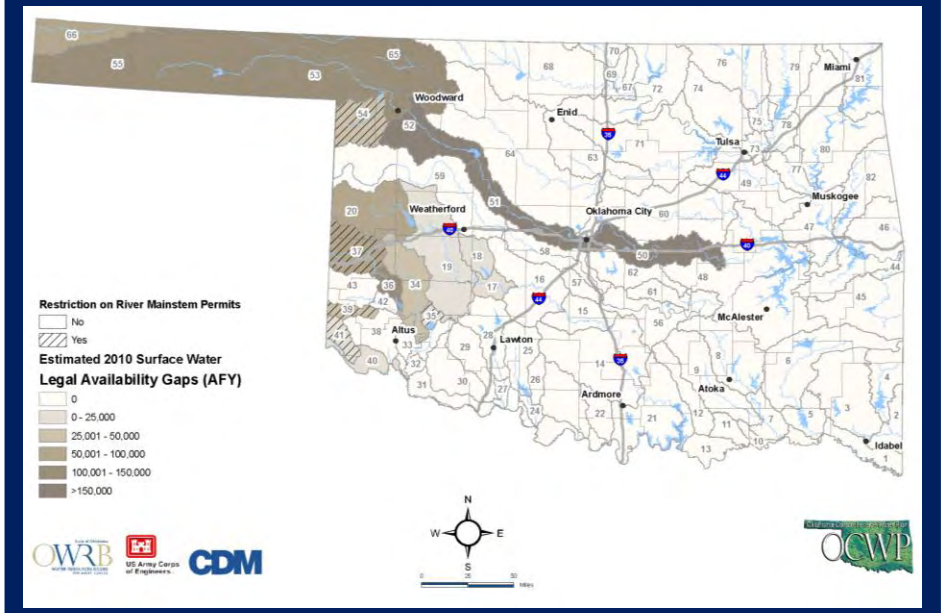
Marginal Quality Water Work Group

October 2010

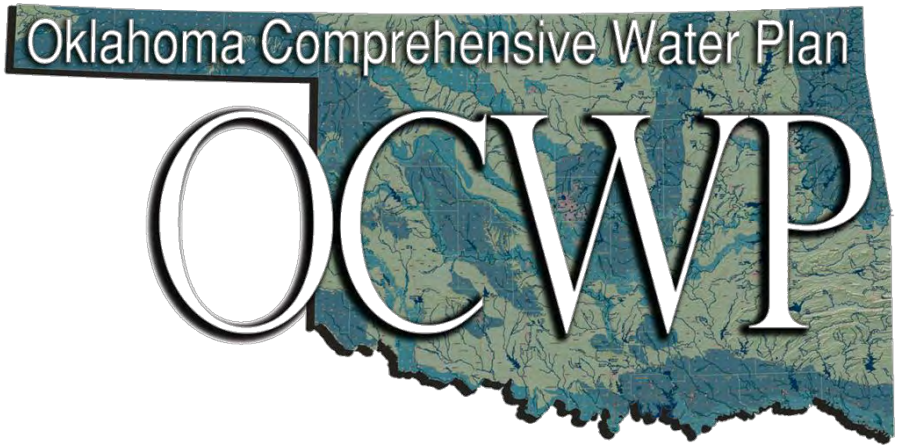
Analyses and Reports Completed



Instream Flows in Oklahoma and the West
October 2009



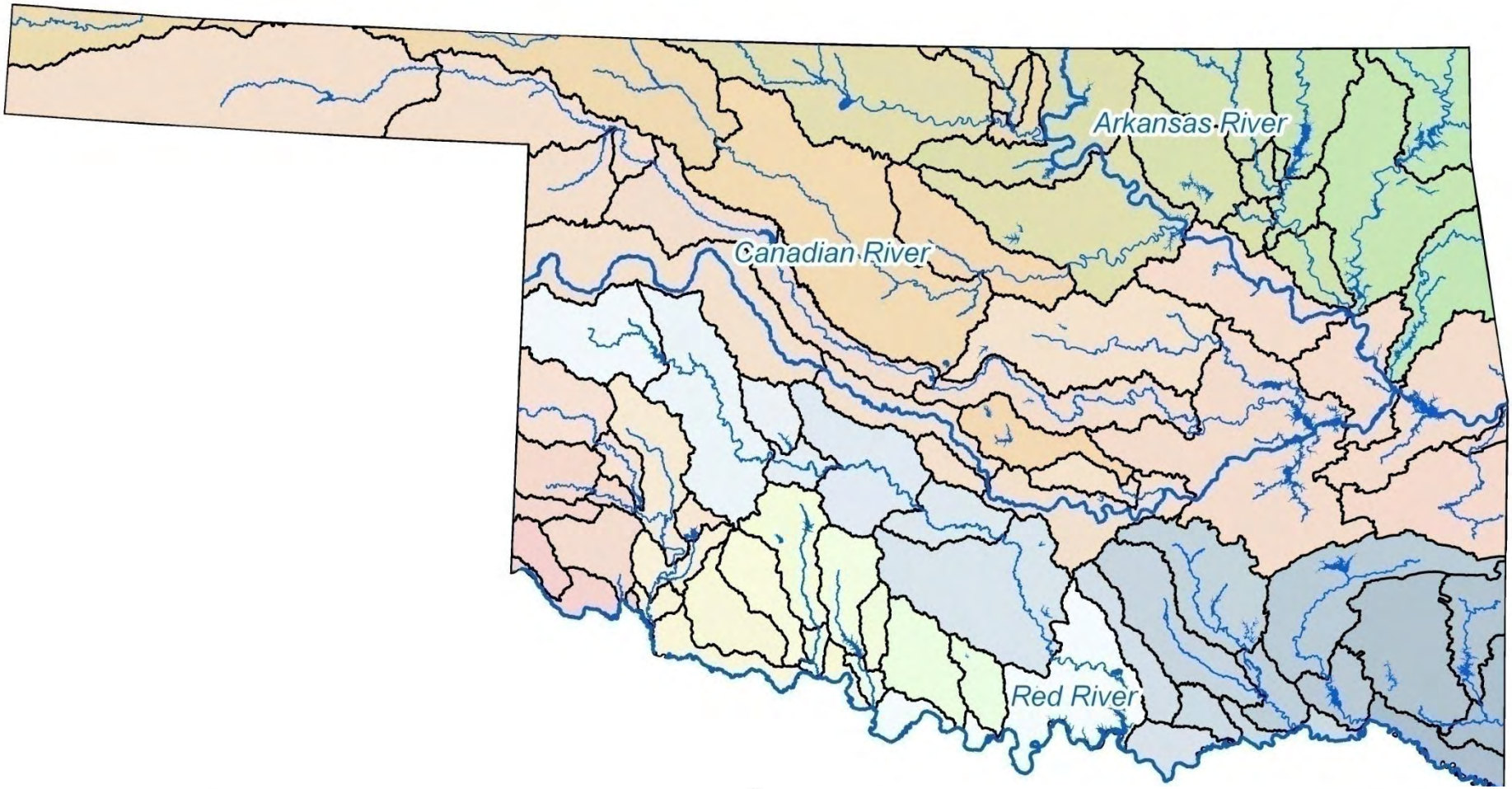
Water Supply Permit Availability
October 2010



Presentation Overview

- Technical Studies Overview
- Work Completed to Date
- **Watershed Planning Regional Reports**
- Additional Work In Progress

82 Basins for Detailed OCWP Analyses



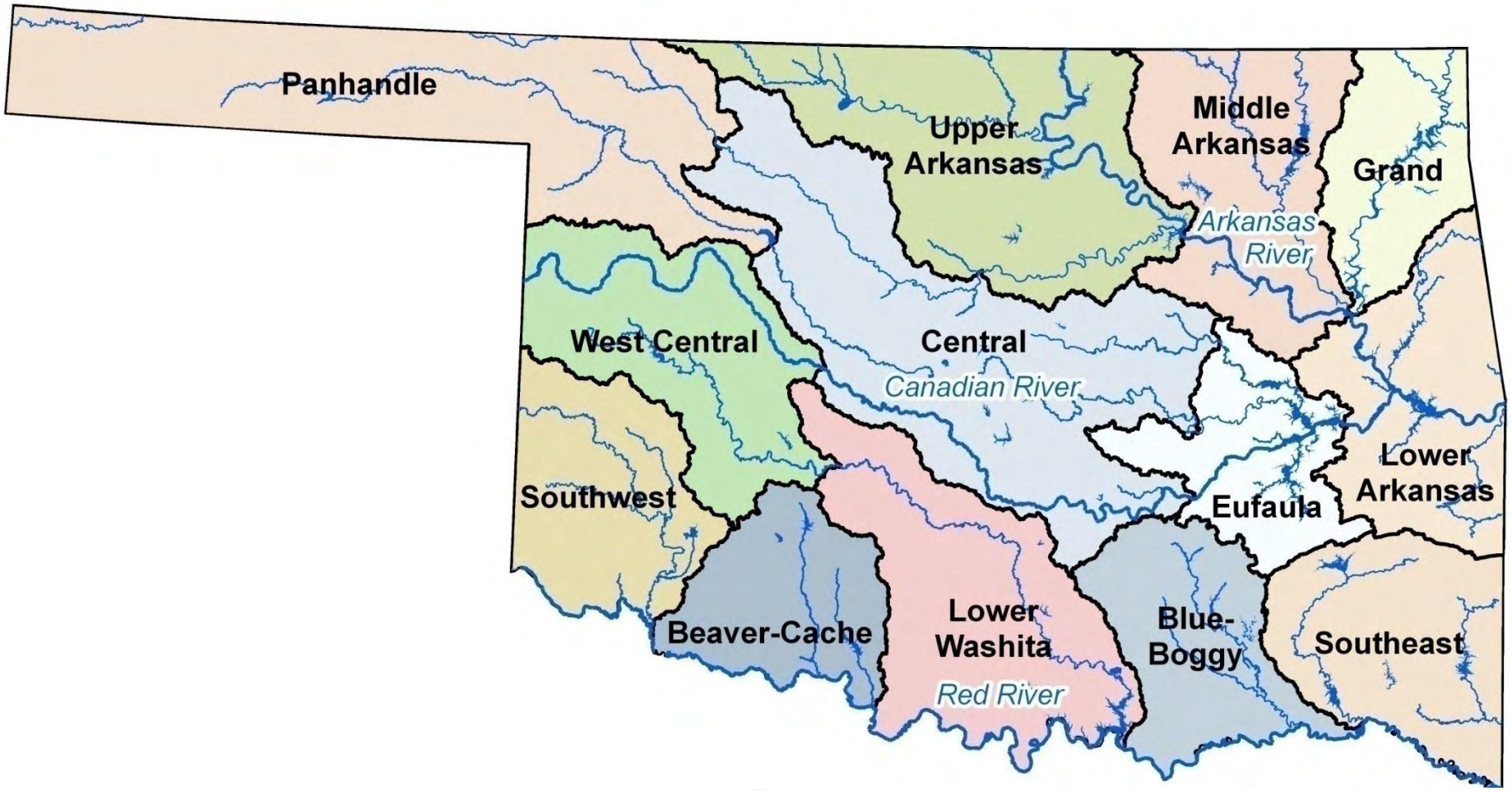
OWRB Water Resources Board — the water agency

US Army Corps of Engineers

CDM

Oklahoma Comprehensive Water Plan
OCWP

Aggregated into 13 Watersheds for Regional Supply Planning



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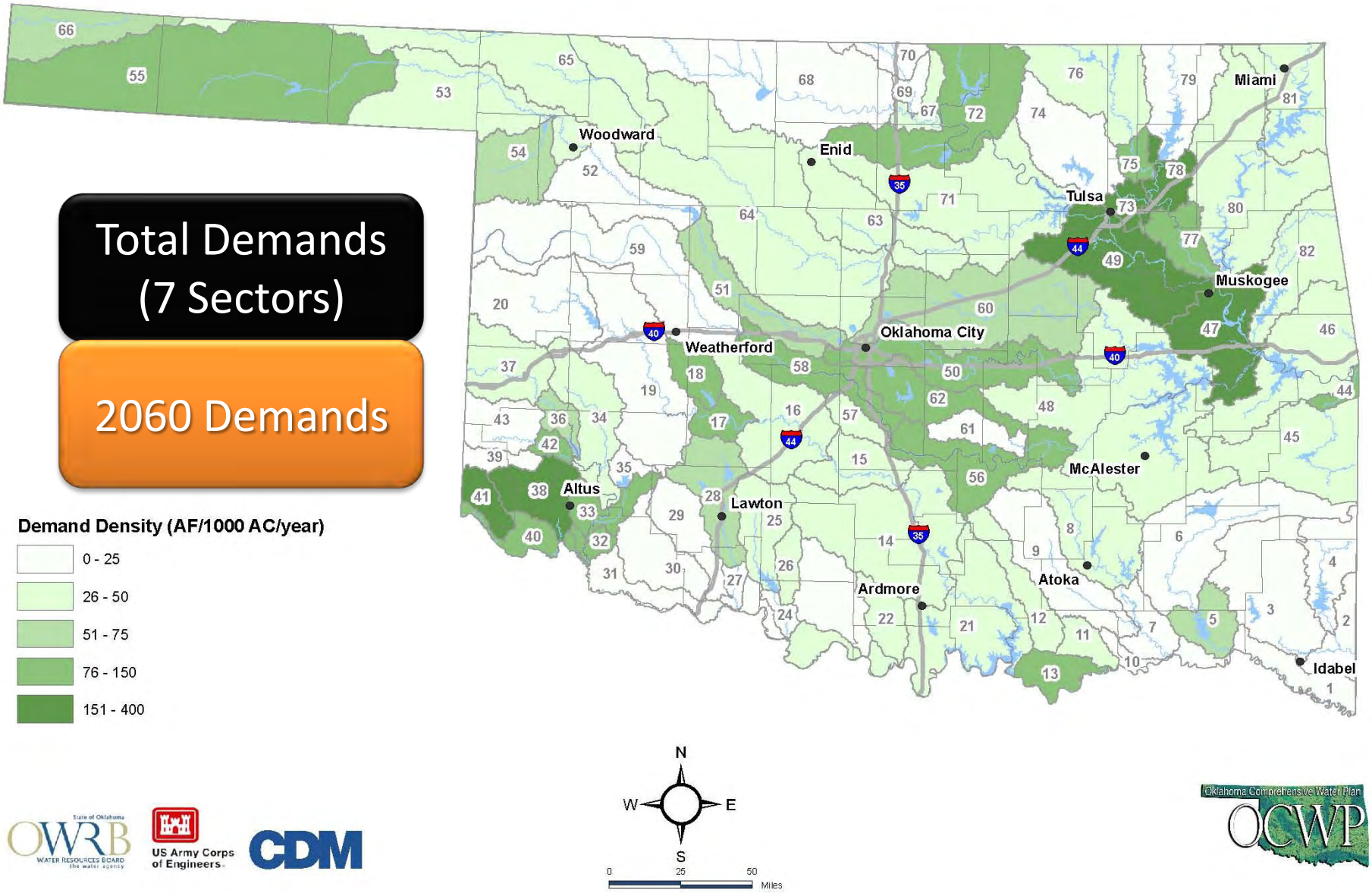
CDM

Oklahoma Comprehensive Water Plan

OCWP



OWRB Water Resources Board — the water agency

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CDM

Oklahoma Comprehensive Water Plan
OCWP

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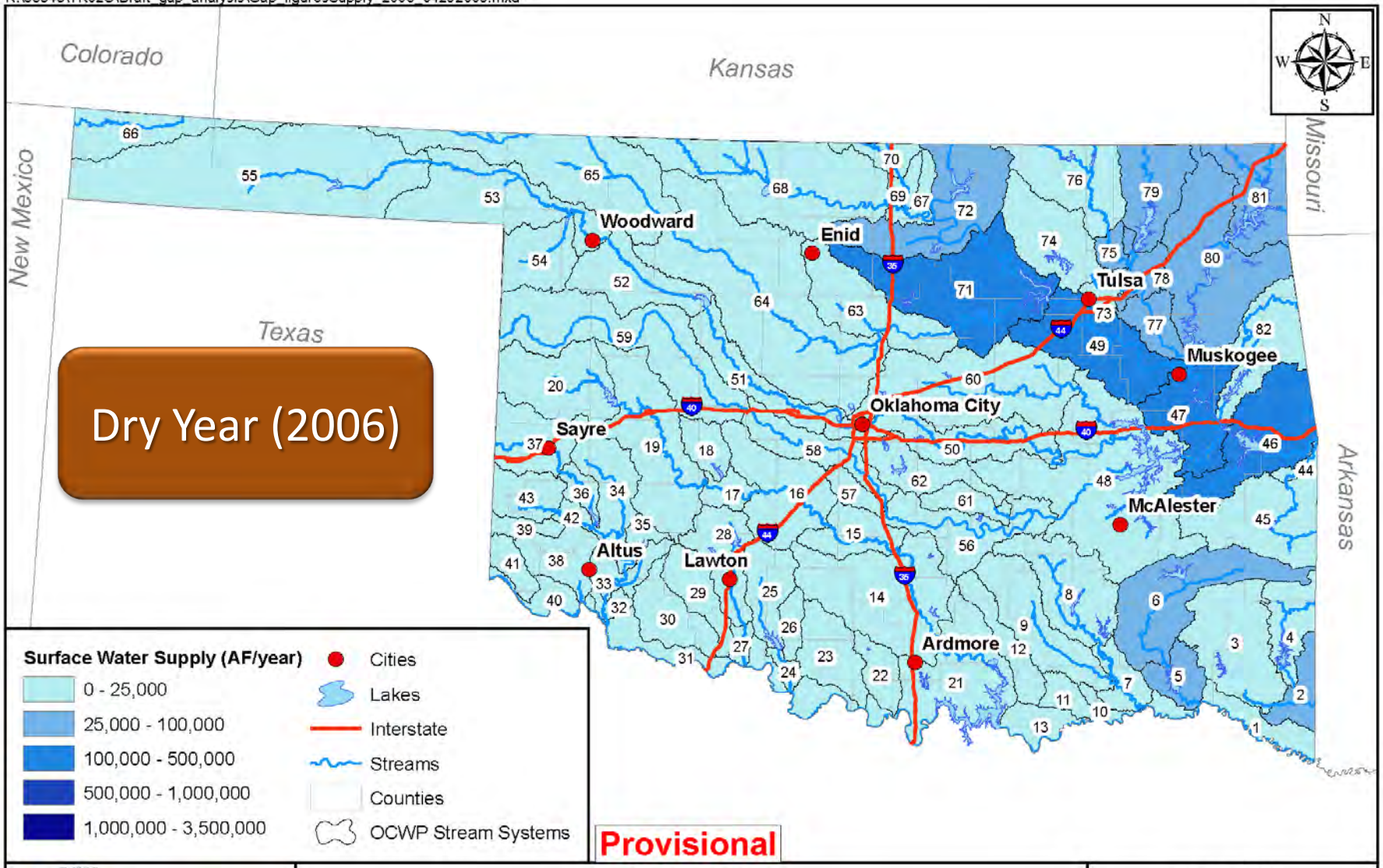

OWRB
US Army Corps of Engineers
CDM
Oklahoma Comprehensive Water Plan

Figure 3-2
Surface Water Supplies for Water Year 2006

05.05.2009

0 25 50 75 Miles

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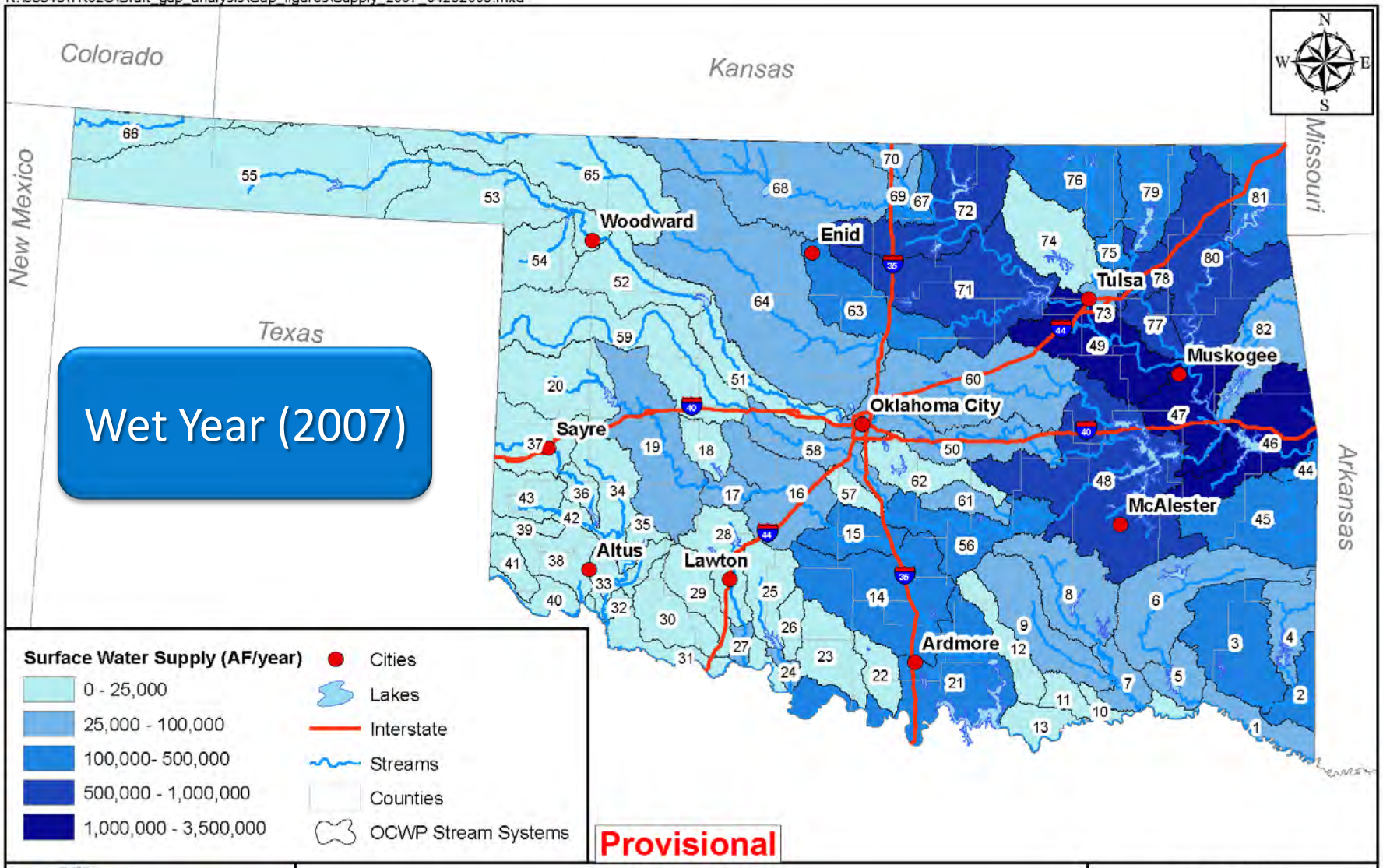


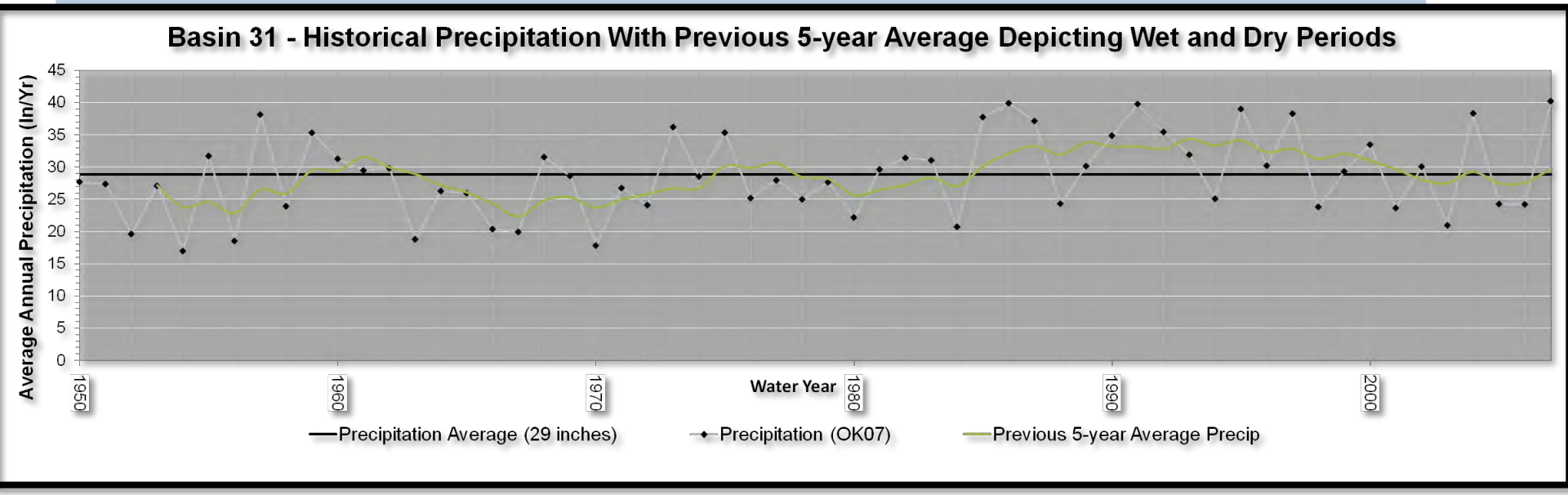
OWRB
US Army Corps of Engineers
CDM
Oklahoma Comprehensive Water Plan

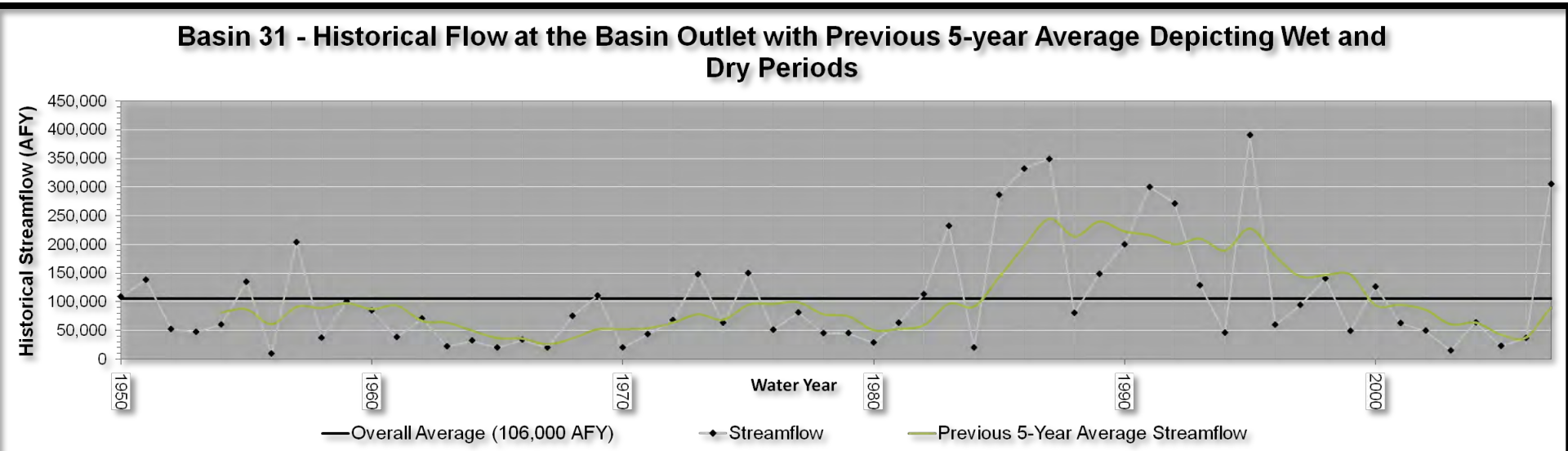
Figure 3-3
Surface Water Supplies for Water Year 2007

05.05.2009

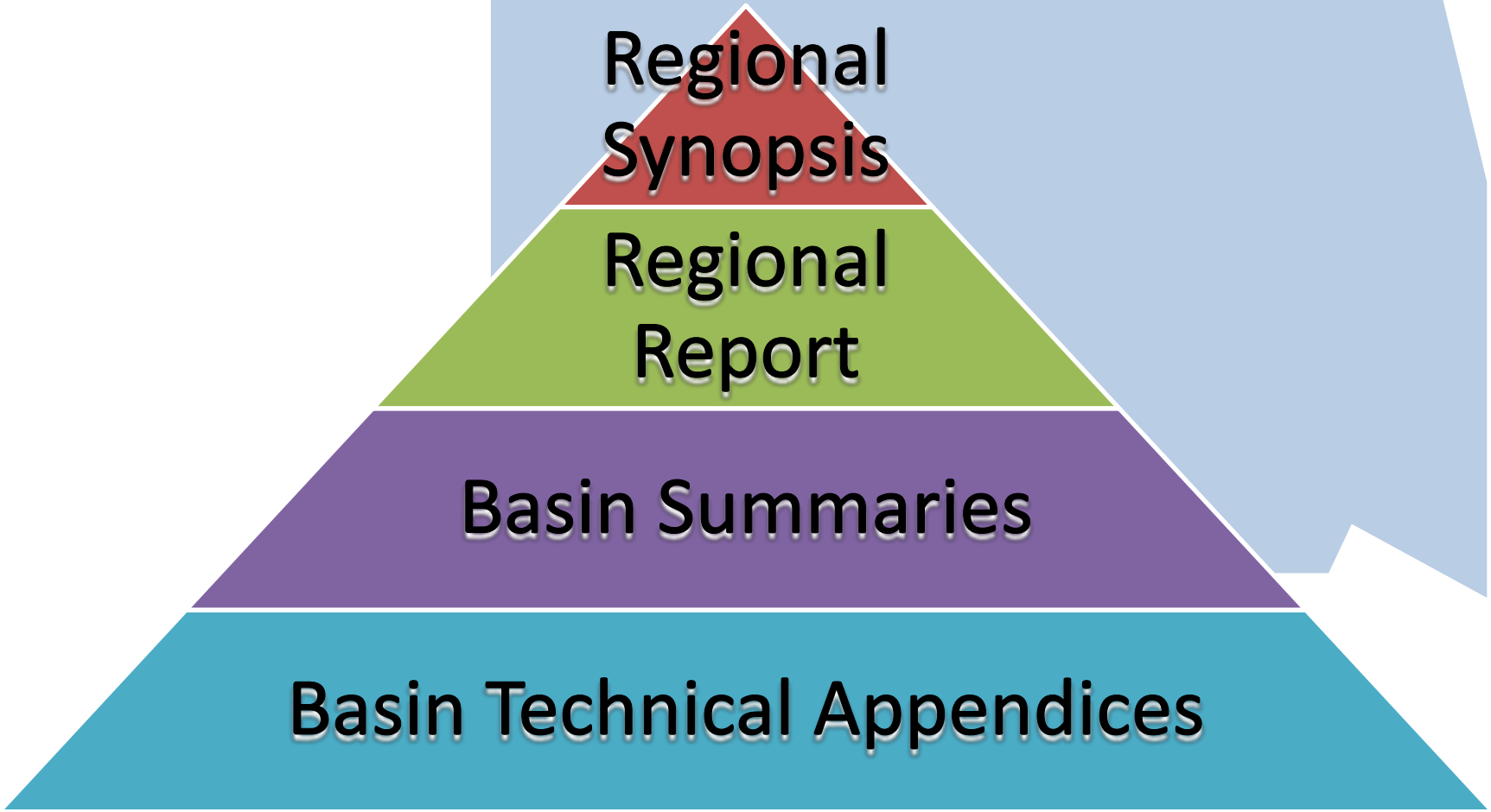
0 25 50 75 Miles

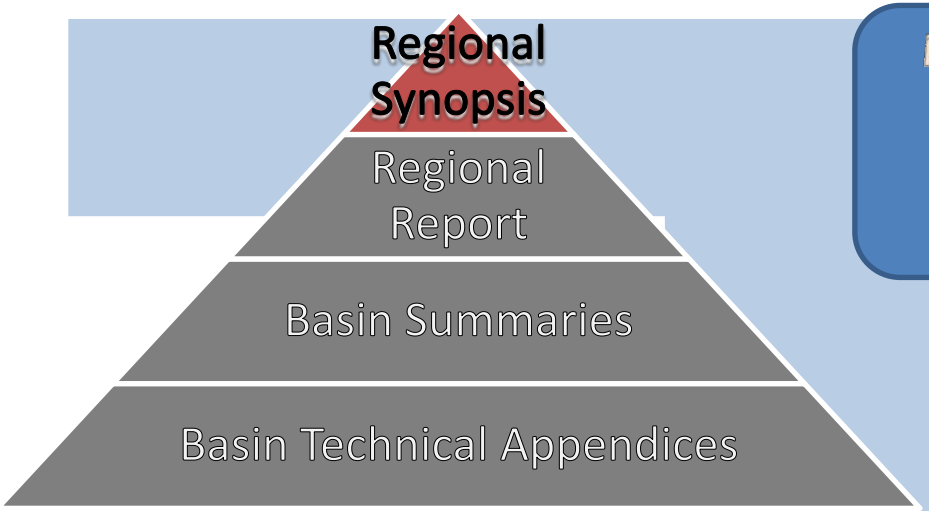
58 years of Precipitation & Flow Record for 82 Basins





Watershed Planning Regional Reports

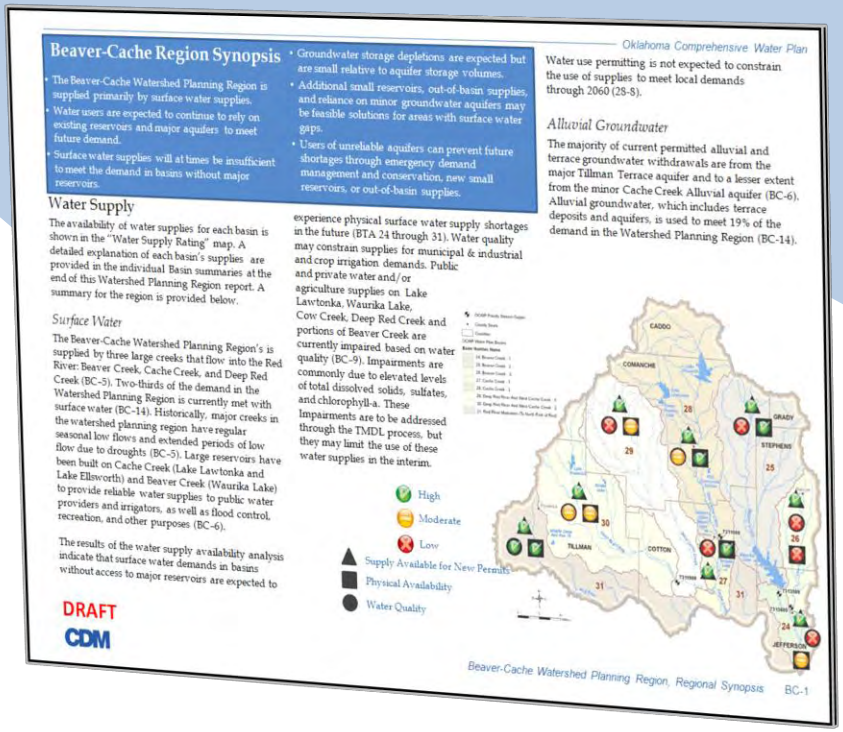




13 Regions

- Physical, Permit, Water Quality summary for each basin in region

- Summary of supply challenges
- Regional water supply and demand summary
- Supply options assessment for each basin in region



Oklahoma Comprehensive Water Plan

Beaver-Cache Region Synopsis

- The Beaver-Cache Watershed Planning Region is supplied primarily by surface water supplies.
- Water users are expected to continue to rely on existing reservoirs and major aquifers to meet future demand.
- Surface water supplies will at times be insufficient to meet the demand in basins without major reservoirs.
- Groundwater storage depletions are expected but are small relative to aquifer storage volumes.
- Additional small reservoirs, out-of-basin supplies, and reliance on minor groundwater aquifers may be feasible solutions for areas with surface water gaps.
- Users of unreliable aquifers can prevent future shortages through emergency demand management and conservation, new small reservoirs, or out-of-basin supplies.

Water Supply

The availability of water supplies for each basin is shown in the "Water Supply Rating" map. A detailed explanation of each basin's supplies are provided in the individual Basin summaries at the end of this Watershed Planning Region report. A summary for the region is provided below.

Surface Water

The Beaver-Cache Watershed Planning Region's is supplied by three large creeks that flow into the Red River: Beaver Creek, Cache Creek, and Deep Red Creek (BC-5). Two-thirds of the demand in the Watershed Planning Region is currently met with surface water (BC-14). Historically, major creeks in the watershed planning region have regular seasonal low flows and extended periods of low flow due to droughts (BC-5). Large reservoirs have been built on Cache Creek (Lake Lawtonka and Lake Ellsworth) and Beaver Creek (Waurika Lake) to provide reliable water supplies to public water providers and irrigators, as well as flood control, recreation, and other purposes (BC-6).

The results of the water supply availability analysis indicate that surface water demands in basins without access to major reservoirs are expected to experience physical surface water supply shortages in the future (BTA 24 through 31). Water quality may constrain supplies for municipal & industrial and crop irrigation demands. Public and private water and/or agriculture supplies on Lake Lawtonka, Waurika Lake, Cow Creek, Deep Red Creek and portions of Beaver Creek are currently impaired based on water quality (BC-9). Impairments are commonly due to elevated levels of total dissolved solids, sulfates, and chlorophyll-a. These Impairments are to be addressed through the TMDL process, but they may limit the use of these water supplies in the interim.

High
Moderate
Low
Supply Available for New Permits
Physical Availability
Water Quality

Water use permitting is not expected to constrain the use of supplies to meet local demands through 2060 (28-8).

Alluvial Groundwater

The majority of current permitted alluvial and terrace groundwater withdrawals are from the major Tillman Terrace aquifer and to a lesser extent from the minor Cache Creek Alluvial aquifer (BC-6). Alluvial groundwater, which includes terrace deposits and aquifers, is used to meet 19% of the demand in the Watershed Planning Region (BC-14).

DRAFT
CDM

Beaver-Cache Watershed Planning Region, Regional Synopsis BC-1

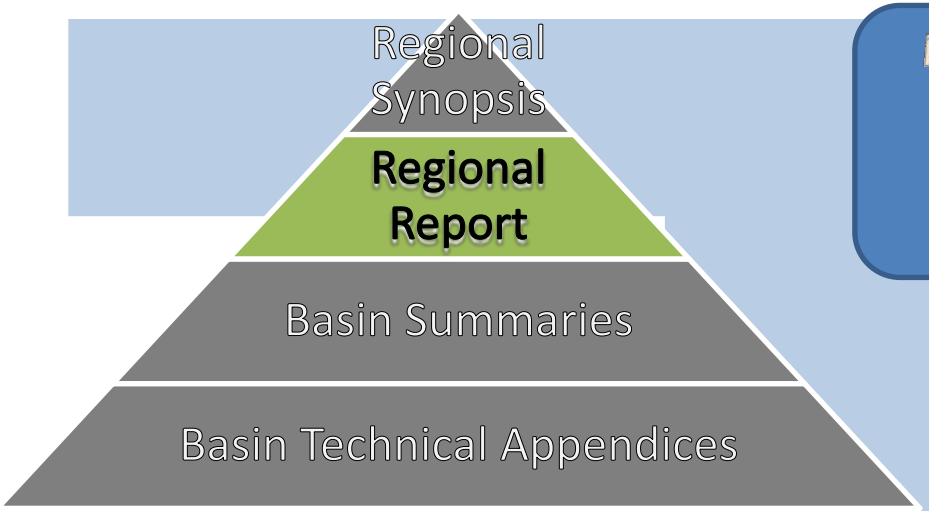
Water Supply Availability

- *Physical supply*
- *Permitting*
- *Water Quality*

- *Not constraining*
- *May constrain use*
- *Likely constraint*

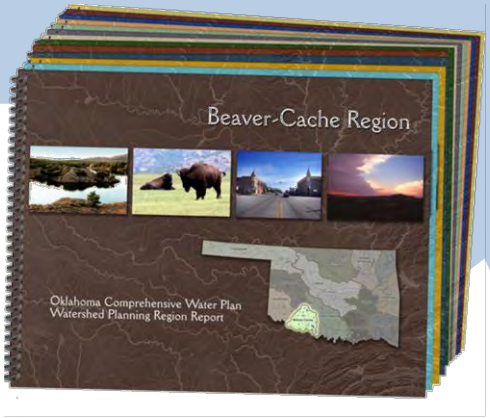
Effectiveness of Alternate Supply Options

- *Demand Reduction*
- *Increased Groundwate Use*
- *Increased Surface Wat Use*
- *Reservoir Storage*
- *Out-of-Basin Supplie*



13 Regions

- Regional map & characteristics
- Surface water & groundwater resources
- Permit availability
- Water quality trends



- Demand by basin, sector, and decade
- Public supply provider details
  - *Population*
  - *Demand*
  - *Interconnects*
  - *Permits*
  - *Infrastructure plans*
- Water supply options assessment by basin

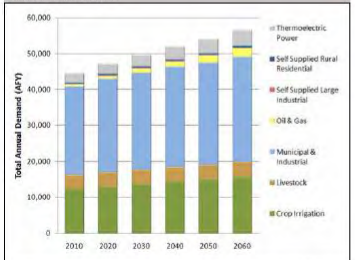
Water Demand

Demand" is a term describing the amount of water used to meet the needs of people, communities, industry, agriculture, and other users. For the OCWP update, demands have been projected from 2010 to 2060 in ten-year increments for seven distinct water user types or "sectors." Demand projections are based on standard methods using data specific to each sector and each OCWP basin, augmented by stakeholder input. These projections were initially developed for each county in the state, and then allocated to each of the 82 OCWP basins.

Growth in water demand often corresponds to growth in population, agriculture, industry, or other economic activity. Future demands were projected independent of available supply, water quality, or infrastructure considerations. Demand sectors are projected to experience different growth rates, resulting in higher projected use of specific water

Total Demand by Sector

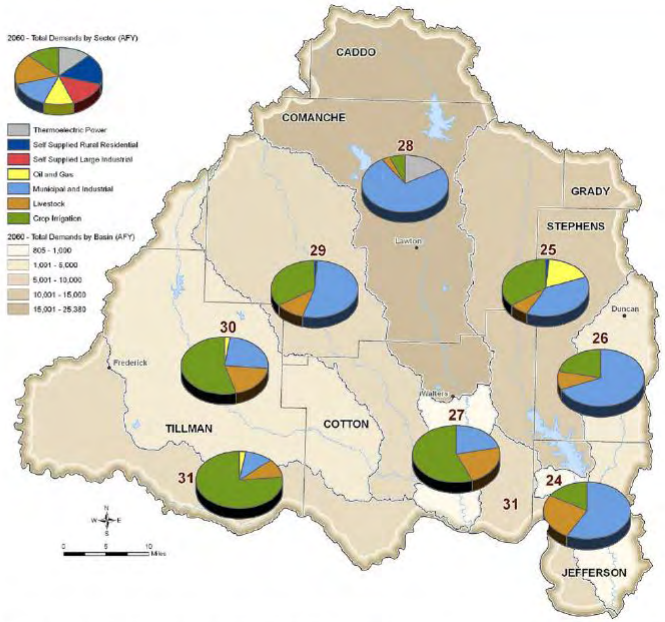
Beaver-Cache Region



NOTE: This region's water needs comprise about 2% of the demand statewide. The demand increases by 27% (12,000 AFY) from 2010 to 2060. The majority of the demand and growth in demand over this period will be in the M&I and Crop Irrigation sectors.

Total Demand by Sector and Basin

Beaver-Cache Region



NOTE: Since Lake Frederick is a public water supply reservoir and has a relatively small watershed, it could potentially benefit from an SWS designation. This designation could provide protection from new or increased loading from point sources in the watershed. This additional protection would also provide limits for algae (chlorophyll a) that can cause taste and odor problems and increased treatment costs.

Public Water Provider Forecast Demand

Beaver-Cache Region

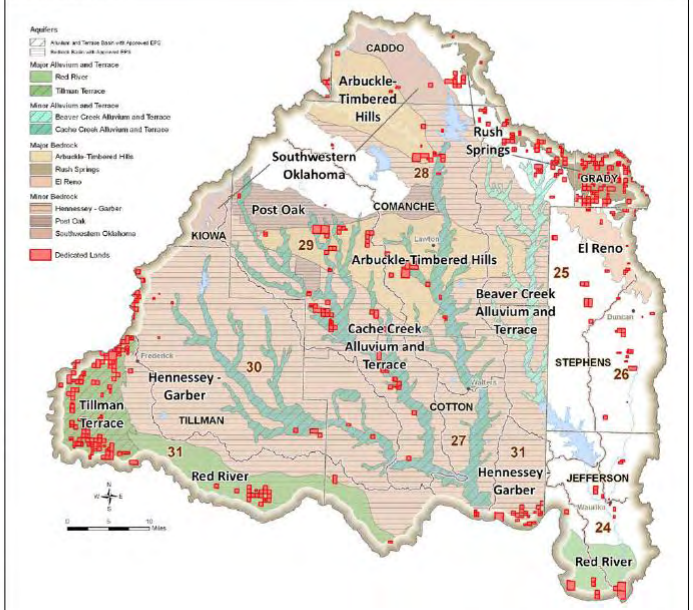
SDWIS ID	Providers	County	Retail Demand Including System Loss (AFY) 2010	2020	2030	2040	2050	2060	Total Demand Including Retail, System Losses, and Sales (AFY) 2010	2020	2030	2040	2050	2060
OK2000806	Apache	Caddo	202	210	216	222	230	236	202	210	216	222	230	236
OK2001607	Cache	Comanche	474	505	533	555	572	585	474	505	533	555	572	585
OK2001608	Chattanooga PWS	Comanche	37	41	42	44	46	46	37	41	42	44	46	46
OK3001602	Comanche Co RWD #1	Comanche	572	611	644	670	690	707	572	611	644	670	690	707
OK2001604	Comanche Co RWD #2	Comanche	162	173	182	190	196	200	162	173	182	190	196	200
OK2001602	Comanche Co RWD #3	Comanche	117	125	132	137	141	145	117	125	132	137	141	145
OK3001654	Comanche Co RWD #4	Comanche	435	464	490	509	525	538	468	497	523	542	558	571
OK1011101	Comanche Public Works	Stephens	482	485	491	497	504	516	608	611	617	623	629	642
OK3001702	Cotton Co RWD # 1	Cotton	73	74	75	76	78	79	73	74	75	76	78	79
OK2001702	Cotton Co RWD #2	Cotton	254	258	261	265	273	277	254	258	261	265	273	277
OK2007104	Davidson	Tillman	81	83	85	87	89	91	81	83	85	87	89	91
OK3001701	Devol	Cotton	18	18	18	18	19	19	18	18	18	18	19	19
OK2001610	Elgin PWS	Comanche	170	182	191	199	204	209	170	182	191	199	204	209
OK3001675	Faxon	Comanche	26	28	30	32	32	34	26	28	30	32	32	34
OK2001612	Fletcher	Comanche	119	127	134	140	144	147	119	127	134	140	144	147
OK1011401	Frederick	Tillman	1,456	1,488	1,520	1,551	1,583	1,631	1,732	1,764	1,796	1,828	1,859	1,907
OK3001680	Geronimo	Comanche	191	204	215	224	230	235	191	204	215	224	230	235
OK2007103	Grandfield	Tillman	179	182	187	191	196	200	258	262	266	270	275	279
OK2007102	Hollister	Tillman	13	13	13	13	13	13	13	13	13	13	13	13
OK2001609	Indiahoma	Comanche	23	24	26	27	27	28	60	61	62	64	64	65
OK3003401	Jefferson Co Cons RWD #1	Jefferson	437	444	451	458	471	484	437	444	451	458	471	484
OK1011303	Lawton	Comanche	22,461	24,033	25,190	26,089	26,796	27,373	25,318	26,890	28,047	28,947	29,653	30,231
OK3007101	Manitou	Tillman	63	63	65	67	67	69	63	63	65	67	67	69
OK3001603	Medicine Park	Comanche	51	55	58	60	61	63	51	55	58	60	61	63
OK3003405	Ryan	Jefferson	151	153	154	156	161	166	151	153	154	156	161	166
OK2006905	Stephens Co RWD #3 (Meridian)	Stephens	134	136	137	139	141	144	136	138	139	141	143	145
OK2001601	Sterling Pwa	Comanche	92	97	103	107	111	113	92	97	103	107	111	113
OK1011306	Temple	Cotton	126	128	131	133	136	138	126	128	131	133	136	138
OK2007107	Tillman Co RWD #1	Tillman	164	167	171	174	177	183	180	183	187	190	194	199
OK1011305	Walters	Cotton	332	337	342	347	357	362	334	339	344	349	359	364
OK1011201	Waurika Public Works Authority	Jefferson	728	739	751	762	785	808	1,351	1,362	1,374	1,385	1,408	1,431
TOTAL			29,821	31,646	33,037	34,140	35,055	35,840	33,873	35,698	37,089	38,191	39,107	39,893

dwater for
cipal, domestic
rrigation
ses. The
tion averages
t in thickness
and wells into this
formation produce200
to 500 GPM. The
water is hard to
very hard with the
water generally
calcium magnesium
bicarbonate type. The
Red River bedrock
aquifer partially
supplies Basins 24
and 31. The Tillman
Terrace aquifer
underlies portions of
Basin 31.

Minor bedrock
aquifers in the
region include
the El Reno, Post
Oak, Southwestern
Oklahoma, and
Hennessey-Garber
aquifers. Minor alluvial
aquifers include the
Beaver Creek and
Cache-Creek Alluvium
and Terrace deposits.
Minor aquifers, such
as the Hennessey-
Garber and Post
Oak, may have a
significant amount of
water in storage and
high recharge rates,
but has low yields,
generally less than 50
GPM. Groundwater

Bedrock and Alluvial Aquifers

Beaver-Cache Region

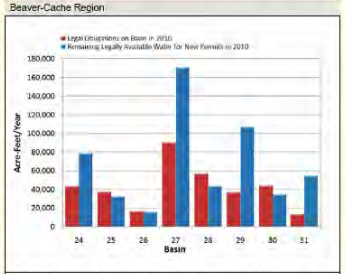


Availability of Water

er is governed by different legal principals in Oklahoma. to be publically-owned and subject to appropriation by d for both groundwater withdrawals and surface water dwater is a property right in Oklahoma. Surface water the prior appropriation doctrine, with the exception of h can be summed up as "First in Time, First in Right". hortage occurs, the diverter with the older permit (first has been set to assure all property owners have equal share to the aquifer's water. The withdrawal amount varies from 1 acre-feet per year per acre to 2 acre-feet per year per acre in the Beaver-Cache Region. If a detail study has not been conducted a provisional or temporary permit is issued, which allows withdrawals up to 2 acre-feet per year per acre. The withdrawal amount of provisional permits may be adjusted based on the results of a detailed study. A groundwater permit only grants the right to withdrawal water; it does not assure the well yield.

Estimated Legally Available Surface Water for New Permits

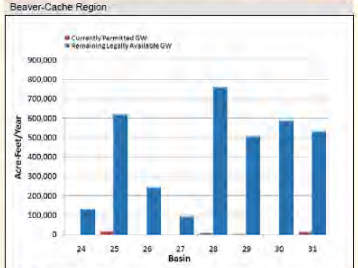
Beaver-Cache Region



NOTE: Projections indicate that there will be surface water available for new permits through the 2060 planning period in all basins in the Beaver-Cache region. There is substantially less water available for permits in Basins 25 and 28 than the other basins in the region. Slight decreases from 2010 to 2060 in the available surface water reflect projections of increases in demand.

Estimated Legally Available Groundwater for New Permits

Beaver-Cache Region



NOTE: The amount of groundwater available for new permits exceeds projected demand for each basin in the Beaver-Cache Region. Groundwater supply may be drawn down over time, and well yields may constrain the amount of water that can be withdrawn from the aquifers.

Dave Boyer, Ellsworth, and Lawtonka Lakes.

Groundwater Resources

Major bedrock groundwater aquifers are available in the northern portion of the Beaver-Cache planning region, from the Arbuckle-Timbered Hills and Rush Springs aquifers. Major alluvial groundwater aquifers are available in the south portion of the planning region, from the Red River and Tillman Terrace aquifers.

The Arbuckle-Timbered Hills aquifer consists predominantly of carbonate formation (limestone and dolomite). The aquifer occurs in two areas: in the Limestone Hills north of the Wichita Mountains and in the Cache-Lawton area south of the Wichita Mountains. Availability of groundwater in the Limestone Hills is erratic because of faulting and folding. Most wells are 500 feet deep or more. Wells and springs yield as much as 100 GPM. In the Cache-Lawton area, well depths range from 350 to more than 2,000 feet, and yields up to 600 GPM have been reported. Because fluoride concentrations generally exceed the drinking water standard, use for public water supply is limited. This aquifer underlies portions of Basins 25, 28 and 29.

The Rush Springs Sandstone is a fine-grained sandstone aquifer with some shale, dolomite, and gypsum. Thickness of the formation ranges from 200 to 300 feet. Well yield is normally between 200 and 600 GPM. The water tends to be of a calcium bicarbonate type and is very hard. This aquifer underlies portions of Basins 25 and 28.

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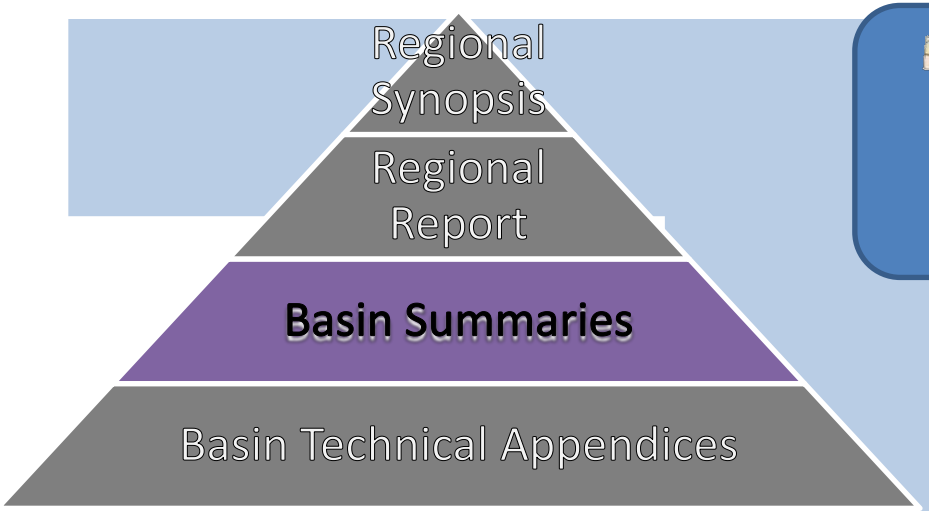
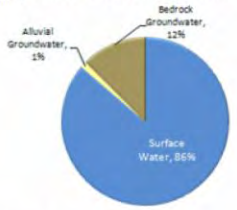


82 Basins

- Summary of supply challenges
- Map & summary of supplies
- Demand by sector & decade

- Potential for supply shortages
- Water supply options & effectiveness
- Constraining factors
  - *Physical supply*
  - *Permits*
  - *Water quality*

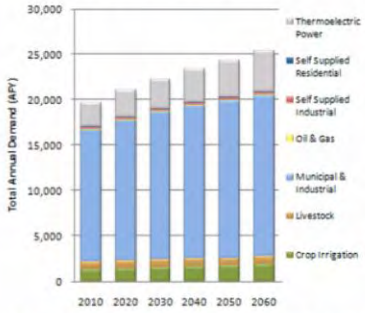
Supply Sources Used to Meet Current Demand (2010)



Water Demand

Basin 28 (Cache Creek-2) makes up 44% of the projected water demand in the Beaver-Cache Watershed Planning Region. The projected 2060 water demand of 25,400 AFY in Basin 28 reflects a 5,800 AFY increase (30%) over the 2010 demand (28 - 4).

Total Demand by Water Use Sector



About two thirds of the demand is in the Municipal & Industrial use sector, with the most significant demands in the Lawton area. Thermoelectric Power is the second-largest water use sector at 13% of the total basin demand (28 - 4). Demands peak in Municipal & Industrial and Crop Irrigation sectors (28 -6).

Potential Future Shortages

On a basin scale, surface water supplies are expected to be adequate for in-basin surface water demand through 2060. This is due to the significant storage in Lakes Lawtonka and Ellsworth. However, localized shortages may occur, and the infrastructure that would be needed to utilize these reservoirs for deman not be cost-effective bedrock groundwat rates in summer and (28-7), but those rate are insignificant rela aquifer storage volu

Supply Optio

Many water heavily on e

New small r alternative t do not have major reserv

The use of m an effective a

Increasing s the potential depletions (2

A 5% reduction in demand via water conservation measures or emergency demand management practices could mitigate the potential for seasonal groundwater drawdown (28-9).

New out-of-basin supplies could also mitigate these conditions, but are less attractive given the availability of in-basin resources (28-9).

Basin 28 Summary

- Streamflow and existing reservoirs in this basin provide reliable surface water supplies; no surface water gaps are expected
- Small alluvial and bedrock groundwater storage depletions may occur by 2060.
- Water quality is a potential concern for both surface water and groundwater supplies
- Many water users will continue to rely heavily on existing major reservoirs
- New small reservoirs or the use of major groundwater aquifers are an effective alternative to meet the demand of users that do not have access to supplies from existing major reservoirs.
- Potential groundwater depletions could be mitigated by conservation or through increased use of surface water supplies.

Water Supply Availability

- Physical Availability
- Water Available for New Permits
- Water Quality

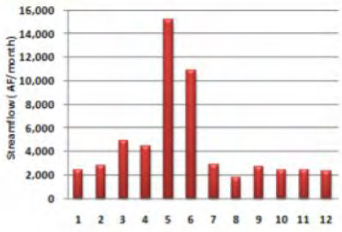
Water Supply

Basin 28 features significant water supply availability in terms of physical supplies and availability of water for new permits, but water quality could affect the use of some supplies. Surface water is used to satisfy about 86% of current demand in the basin (28-4). Cache Creek, the largest stream in the basin, typically has peak flows in the spring and early summer, but has also historically seen periods of prolonged low streamflow (28-2). This underscores the importance of reservoir storage for surface water supply reliability in the basin. Streamflow is regulated in part by the City of Lawton's two large water supply reservoirs, Lakes Lawtonka and Ellsworth with a combined dependable yield of 47,000 AFY (BC - 6).

Several major and minor groundwater aquifers also form an important component of the basin's water resources. Minor aquifers provide lower yields and may therefore have limited ability to meet water demand of high volume users (28-3). The use of surface water and groundwater to meet in-basin demand is not expected to be constrained by the availability of permits for new water diversions through 2060 (BC - 8).

Water quality issues include impairment designations for several streams and lakes, including the listing of Lake Lawtonka as impaired for Public and Private Water Supply Use due to elevated levels of Chlorophyll-a (BC - 9). Surface water quality data in several streams and lakes in the basin suggest an upward trend in conductivity (BC - 12). Fluoride concentrations and brackish salinity levels in the Arbuckle-Timbered Hills bedrock aquifer, the largest and most widespread aquifer, may limit the use of groundwater for most users (BC - 7).

Median Historical Streamflow at the Basin Outlet



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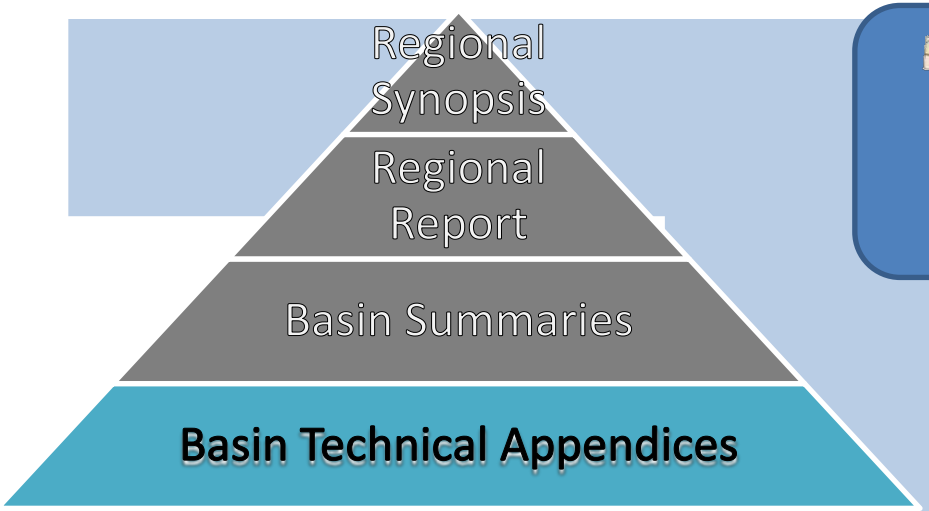
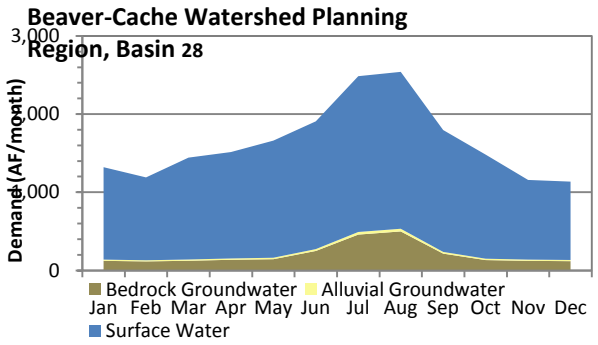
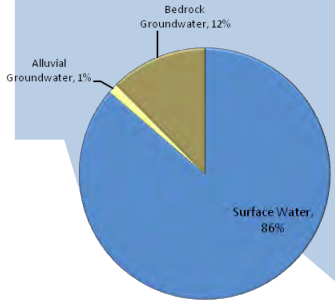
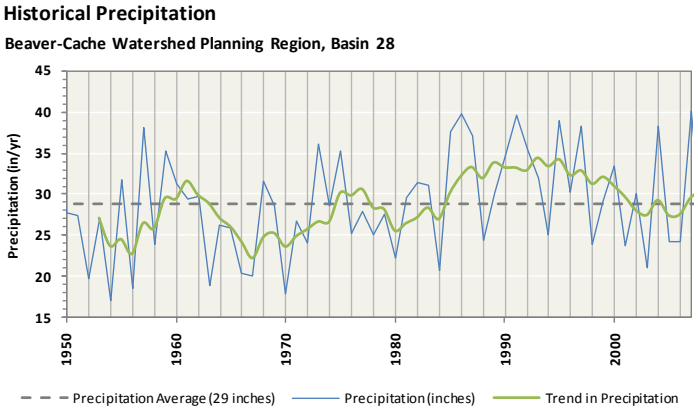


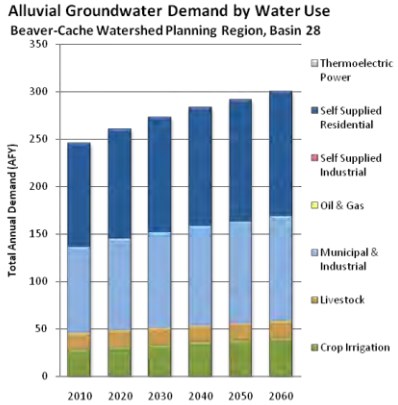
82 Basins

- Charts
- Tables
- Additional details
  - *Supply*
  - *Demand*
  - *Shortages*
  - *Supply options*







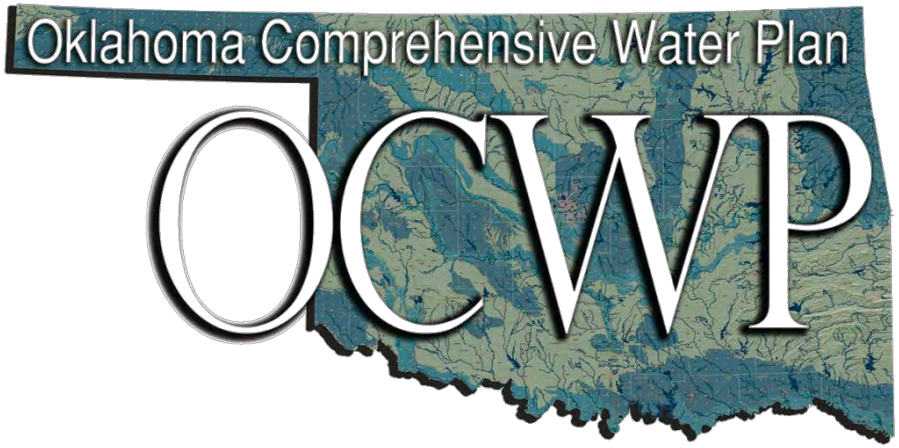


Magnitude and Probability of Annual Gaps and

Beaver-Cache Watershed Planning Region, Basin 28

Planning Horizon	Maximum Gaps/Storage Depletions		
	Surface Water	Alluvial Groundwater	Bedro Groundw
2020	0	0	0
2030	0	0	0
2040	0	0	0
2050	0	0	0
2060	0	10	10

Table last updated 10/8/2010



Presentation Overview

- Technical Studies Overview
- Work Completed to Date
- Watershed Planning Regional Reports
- **Additional Work In Progress**

WaterSMART Grant: Climate Change Analyses

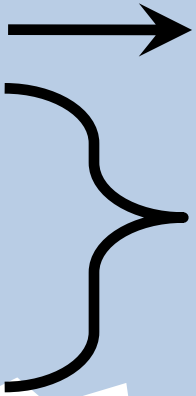
RECLAMATION
Managing Water in the West

- Grant award announced August 2010
- New partnership to leverage resources & expertise
  - *Bureau of Reclamation*
  - *Oklahoma Water Resources Board*
  - *Oklahoma Climatological Survey*
  - *CDM*
- Integrate climate change effects (supplies and evaporation) directly into Reservoir Yield Model
- Bring national level research to the practitioner's level with access to tools and data

Work in Progress & Upcoming

under USACE / OWRB authorities

- Major supply challenges – statewide assessment of "hot spots"
- Climate change (Supply & Demand)
- Conservation potential (M&I & Crop Irrigation)
- Conjunctive management report: Practices employed in other states



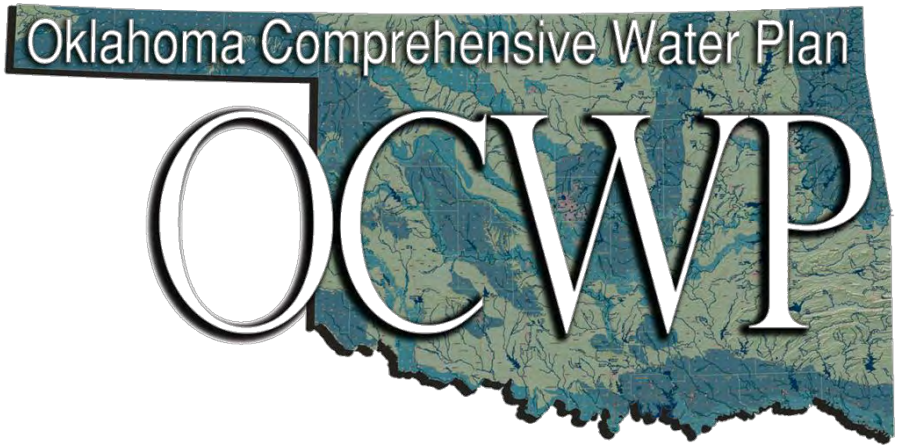
Reservoir yield model

Oklahoma H_2O → Potential shortages

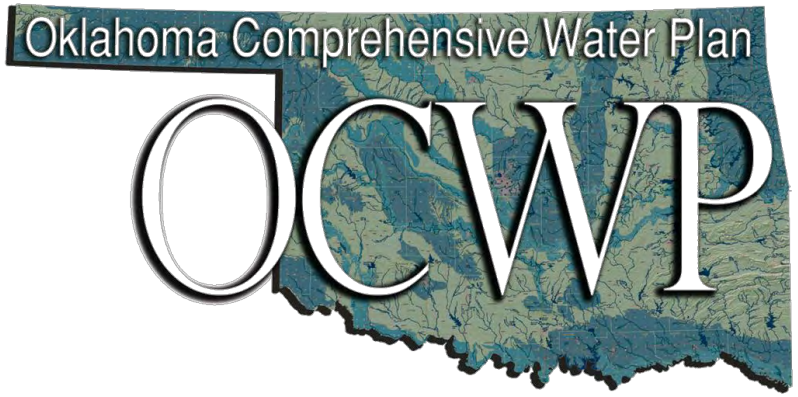
Work in Progress & Upcoming

under USACE / OWRB authorities

- Physical Supply Availability Report – Baseline, Climate Change, and Conservation
- Drinking water and wastewater infrastructure cost projections
- Watershed Planning Region Reports & Basin Technical Appendices
- Provider Planning Guide
  - *Supply planning roadmap*
  - *Criteria for evaluating supply options*
  - *Guide to OCWP resources to support decision-making*



- New model for local-state-federal partnerships
- Watershed and regional approach
- Technical information in multiple levels of detail
- Information to support informed decision-making, policies, and local water planning



OCWP Technical Studies: 2010 Progress and a Look Ahead to 2011

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US Army Corps of Engineers

State of Oklahoma OWRB Water Resources Board the water agency

CDM